UAH Propulsion Research Center

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The University of Alabama in Huntsville

Grand Challenges in Propulsion Research
Workshop Chairs

Dr. Robert Frederick, Jr.
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Back Row: Robert Frederick, UAHuntsville, Mark Brandyberry, University of Illinois; Robert Santoro, Penn State, Alan Wilhite, Georgia Tech.; Vadim Smelyanskiy, NASA Ames; Shankar Mahalingam, UAHuntsville.
Front Row: Ken Yu, University of Maryland; Roy Hartfield; Auburn ; C.P. Chen; UAH; Mitchell Walker; Georgia Tech; and Bill Anderson, Purdue University.
Brian Cantwell; Stanford to present on October 28th at UAH.

October 14, 2010,
Huntsville, AL

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Overview of Discussion

Questions

- What is the State of Industry?
- What is the state of the art in academia?

Issues/Concerns

- Issues facing Academia
- Concerns about how we are going to achieve the mission together

Recommendations

- Grand Challenges in Propulsion Research
- Grand Challenges in Propulsion Education
- Grand Challenges in Propulsion Technology development

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Propulsion Technologies – Moderator Robert Frederick

8:30 UAH Propulsion Research	**David Linebery Jason Cassibry C.P. Chen**
9:00 A University Perspective on the Needs for Future Space Propulsion and Effective NASA-University Programs	**Robert Santoro**
9:30 Research at Georgia Tech	**Mitchell Walker**
10:00 Flame-Acoustic Interaction in Shear-Coaxial Injectors	**Kenneth Yu**
10:30 Research Needs for Liquid Rocket Engines	**William Anderson**

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Propulsion Modeling and Technology Development – Moderator Shankar Mahalingam

1:00 Space: Near and Far Term	Alan Wilhite
1:30 Mathematical and critical physics analysis of engineering problems: old-new way of doing things	V. Smelyanskiy
2:00 Multiphysics, Multiphase and Multiscale Solid Rocket Motor Simulations at Illinois	Mark Brandyberry
2:30 Modeling and optimization of Rocket Propelled Systems	Roy Hartfeild
3:00 Break/Contingency	

Panel Discussion – Moderator Robert Frederick

3:30 Group Discussion — Robert Frederick

- Topic 1 – Grand Challenges in Propulsion Research
- Topic 2 – Grand Challenges in Propulsion Education
- Topic 3 – Grand Challenges in Propulsion Technology Development

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Current State of Space Industry

(Bob Santoro)

- No access to low earth orbit (LEO) since Space Shuttle retirement.
- Access to Space Station dependent on Soyuz in the near term.
- Decision is to enable and rely on commercial space launch capabilities to provide access to LEO in the near term and eventually beyond LEO.
- 2011 NASA Strategic Plan notes current U.S. launch capability for many planetary missions only possible using Delta and Atlas vehicles.
- Despite the announcement of SLS, traditional rocket companies are shedding workers.

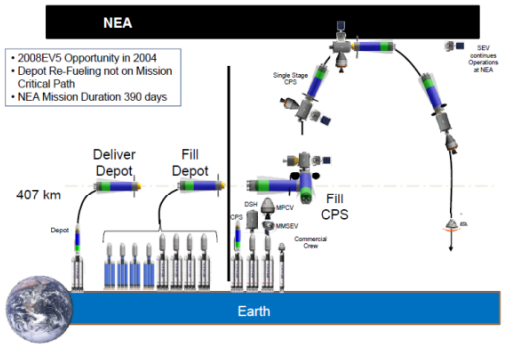
Current State of Industry

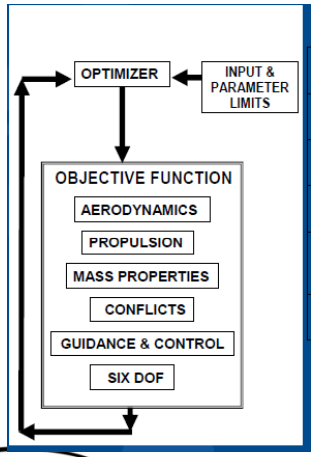
(Bob Santoro)

- Promising launch vehicles such as the Space-X Falcon 9 and Orbital Sciences Taurus II rely on old engine technology such as the former TRW pintle-based injector technology or the Russian NK-33 engine, respectively.
- Use of innovations related to advances in lighter, stronger materials and electronics for Avionics, Guidance/Navigation/Control have impacted reliability and lowered cost for these vehicles.
- But their heritage is based on accomplishments championed in the 1960's.

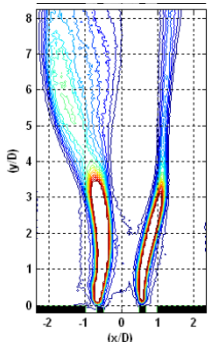
Current State of Academia

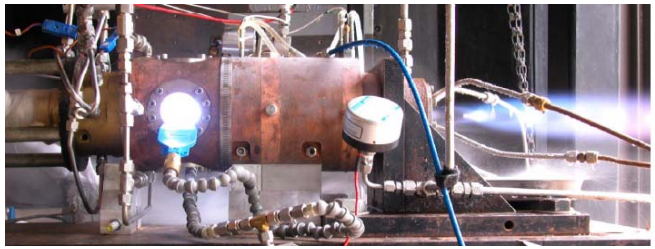
System Architecture and Cost

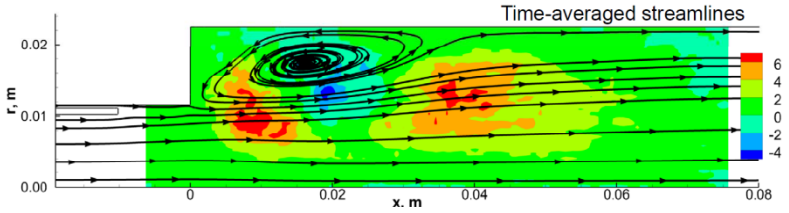




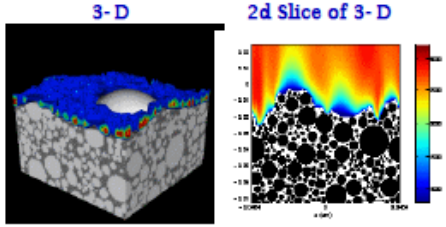
Fundamental Processes

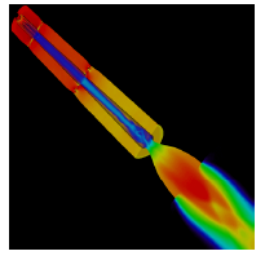


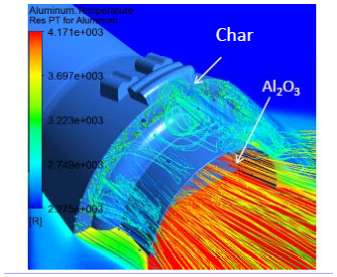




Multi-Physics Modeling







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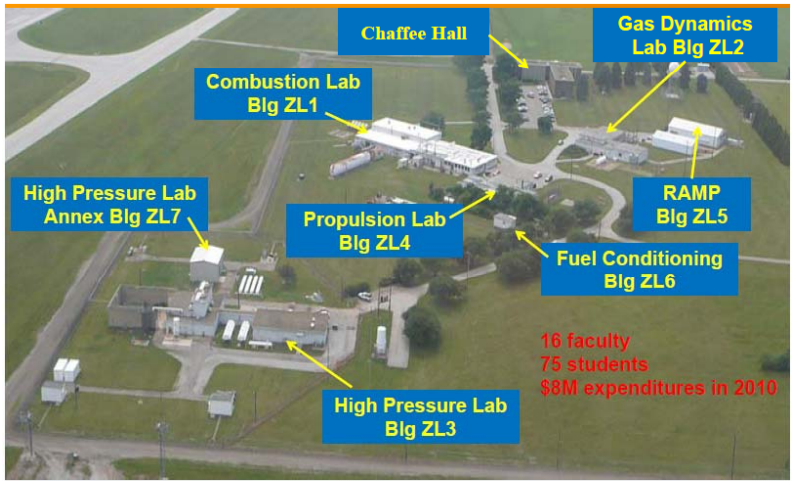
% NASA Funding of Propulsion of Propulsion-Related Groups at Universities Represented (ROM)

- Purdue (20%)
- Penn State (20%)
- UAHuntsville (15%)
- GIT Atlanta (<10%)



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Tale of Two Cities

(Ken Yu Maryland)

Industry

- Much experience with practical systems
- Development, testing and implementation
- Identifying system deficiencies and research areas
- Keeper of the engineering knowhow (proprietary)
- Driven by near-term profit and business needs

(concerns: near-term becoming shorter, investment smaller, and business area narrower)

Academia

- Academic freedom to remove/impose constraints
- Decoupling complex processes and analyzing the physics
- Training new generation of propulsion scientists and engineers
- Keeper of the scientific knowhow (multi-disciplinary expertise)
- Driven by long-term contribution and publication needs

(concerns: cost of innovation/ education and need for open discussion and unrestricted sharing)

Effective NASA /University Programs

(Bob Santoro)

- **Continuity over the graduate student's degree program (minimum 3 years).**
- **Do not tie academic research programs to current development programs.**
  - **Makes them compete for resources with mission critical elements.**
  - **Do not put their milestones in a critical path as research progress can not be scheduled.**
- **University research overall must be relevant to NASA near and long-term program goals**

Grand Challenges in Propulsion Research

Issue	Stewardship	Technology	Solutions Facilitator
Mission/Vision/Strategic Direction	• Lack of realization for comprehensive National Space Policy • Lack of multi-Agency vision • **Lack of defined space missions**	• **Lack of integrated defined propulsion technology needs and roadmaps**	• Lack of coordinated 'nation-centric' approach for providing solutions
Financial/Budgetary	• Lack of predictable, long-term funding	• **Lack of sustained technology funding**	• Overcapacity of production capability • Rising supplier costs
Workforce/Skills Retention	• Frequent program/project starts and cancellations • Overall decline in demand for aerospace engineers	• Fewer engineers have experience in technology development, from concept to the field	• Difficulty in access to government expertise • Aging workforce in propulsion expertise
Sustainment/Viability	• Broad impact due to Shuttle retirement • **Uncertainty in future needs** • Large solid rocket motor industrial base decline	• **Lack of long-term development programs & technology investments** • Lack of technology infusion into programs	• Systems infrastructure, supply chain, & skill base challenges
Infrastructure	• Industrial capacity too large for current funding/demand • Declining readiness of current facilities	• Increased cost and reduced availability of critical infrastructure for technology development	• Duplication/redundancy of facilities & capabilities • Difficulty in access to government facilities • Aging facilities

Participants offered content for items in red during presentations and discussion

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General Comments

- Need a compelling mission
- Insure a proper mix of DoD and NASA Research
- Insure proper industry buy in for university research work (transition research and students into industry; understand pull)
- Provide means for integrating government, industry, and academic researchers and engineers
  - NASA CUIP Program was a Model for Healthy Government/University Interactions
  - French-German collaborations on high pressure HO systems and combustion instability are sustainable and productive
- Invest in High Risk High Payoff Technology in Foundational Research Now (i.e. Combustion Instability/Crosscutting Disciplines/Life Prediction)
- Affordability/Demand is Critical to the Future (NASA Cost Models do not Include University Research)
- Focus on most difficult problems that *require* collaboration between multiple disciplines (but do not eliminate individual researcher contributions)

NIRPS Academic Advisory Group Future

- Support NIRPS Planning
- Host Annual Academic Strategy Meeting
- Present Capabilities Papers for National Space Symposium
- Refine Research Topic Recommendations

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THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

PENNSTATE
1855

STANFORD
UNIVERSITY

Georgia Tech
Daniel Guggenheim School of Aerospace Engineering

"Opportunity goes where the best people go, and the best people go where good education goes."
W. Von Braun

AUBURN

PURDUE PROPULSION

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18 56

1867 ™
ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

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